

# The Impact of Innovation on the Financial Performance of Pharmaceutical Enterprises in the Digital Era

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## Abstract

**With the continuous evolution of the economic and social landscape, market competition among enterprises has intensified sharply. To establish core competitive advantages, seize market opportunities, and enhance their strategic position, firms are compelled to strengthen innovation capability, of which patents serve as the most direct and measurable indicator. Using pharmaceutical enterprises as research subjects, this study proposes research hypotheses, identifies variables, constructs classification criteria, and develops an empirical research model. Linear regression analysis is employed to examine the impact of innovation on corporate financial performance in the digital era. The empirical results indicate that innovation exerts a significant positive effect on financial performance among pharmaceutical enterprises. Moreover, compared with state-owned firms, innovation input enhances financial performance more strongly in non-state-owned enterprises. Likewise, relative to small and medium-sized firms, innovation contributes more significantly to financial performance in large enterprises. Based on these findings, this study proposes policy recommendations, including formulating reasonable innovation strategies and improving corporate innovation incentive mechanisms. These suggestions offer practical guidance for promoting innovation and improving financial performance within pharmaceutical enterprises.**

## Keywords

**Corporate Innovation; Financial Performance; Pharmaceutical Enterprises.**

## 1. Introduction

In the current digital era, China's economic structure is undergoing a profound transformation, characterized by the rapid expansion of the digital economy. According to CCTV Finance-Economic Information Network, the scale of China's digital economy exceeded RMB 55 trillion in 2023, accounting for more than 40% of the national GDP. Digitalization has become a core driver of global economic growth amid accelerated technological development. Against this backdrop, promoting enterprise innovation is not only a critical pathway to enhancing competitiveness but also a strategic choice for sustaining long-term development and improving financial performance.

In contemporary capital markets, innovation capability has become a key indicator for investors when valuing pharmaceutical firms. With access to expanding financing channels, pharmaceutical enterprises can increase R&D inputs, forming a positive cycle of "enhanced innovation capability-investment attraction-greater R&D funding-further innovation improvement."

Financial performance represents the foundation of enterprise survival and development and serves as a crucial measure of operational outcomes. It reflects profitability, solvency, operational efficiency, and growth potential, directly influencing value creation and shareholder returns. Under digital transformation, innovation-driven investment growth, cost restructuring, and revenue model evolution exert significant influence on financial performance.

## 2. Literature Review

### 2.1. Concept of Innovation in Pharmaceutical Enterprises

Pharmaceutical innovation refers to the dynamic process by which firms-driven by medical needs, improved clinical efficacy, and industrial value enhancement-achieve breakthroughs in pharmaceuticals, medical devices, and healthcare services through technological R&D, business model reform, and management optimization. The observable outcomes include increased patent grants and improved financial performance.

Miao Fenfen <sup>[1]</sup> finds that corporate income tax incentives positively affect innovation investment in pharmaceutical manufacturing. Ma Yiqiu <sup>[2]</sup> evaluates innovation using R&D expenditure and highlights the moderating role of government intervention and marketization.

### 2.2. Determinants of Corporate Financial Performance

Existing research indicates that CSR engagement, R&D investment, and human capital incentives influence financial performance. Yu Meili <sup>[3]</sup> finds a nonlinear relationship between R&D investment and financial performance in manufacturing firms.

### 2.3. Impact of Innovation on Financial Performance

Corporate financial performance reflects the financial outcomes of strategic and managerial decisions within a given operational period. Fan Yanan <sup>[4]</sup> argues that innovation is fundamental to restructuring transaction mechanisms, creating value, and improving performance. Zou Qinqin <sup>[5]</sup> suggests that business model innovation significantly enhances operational efficiency and financial outcomes.

## 3. Research Hypotheses and Design

### 3.1. Research Hypotheses

**H1:** Innovation in pharmaceutical enterprises exerts a significant positive effect on financial performance.

**H2:** Enterprise heterogeneity moderates the relationship between innovation and financial performance.

**H2a:** The positive effect of innovation on financial performance is stronger in non-state-owned enterprises than in state-owned enterprises.

**H2b:** The positive effect of innovation on financial performance is stronger in large enterprises than in small and medium-sized enterprises.

### 3.2. Variable Selection

#### 3.2.1. Data Sources

Sample data of pharmaceutical enterprises from 2010 to 2023 were collected by searching the CSMAR database and reviewing annual reports of listed pharmaceutical firms. The pharmaceutical industry was selected primarily because it is highly dependent on technological R&D, exhibits strong information transparency, and provides accessible data on patents, assets, and other indicators. Moreover, patents account for a relatively large proportion of the

intellectual property portfolio of pharmaceutical firms, making them a suitable proxy for measuring innovation. Additionally, financial performance in the pharmaceutical sector is strongly influenced by innovation activities, as the successful commercialization of new drugs significantly increases corporate revenue.

To ensure the feasibility and accuracy of the research, data cleaning and sample screening procedures were conducted to enhance data reliability and validity. The specific screening criteria were as follows:

- (1) Firms labeled as ST or \*ST were excluded, as they are highly likely to experience financial distress or operational instability, resulting in reduced data representativeness;
- (2) Firms with missing financial or patent data were removed to avoid biases arising from data incompleteness;
- (3) All continuous variables were winsorized at the 1% and 99% levels to mitigate the influence of extreme outliers on empirical results.

Ultimately, 390 pharmaceutical firms were retained as the final research sample. All statistical analyses were conducted using Excel 2019 and Stata 17.0.

### 3.2.2. Variable Definitions

#### (1) Independent Variable

Corporate innovation (**Patent**). Patent counts are widely used to measure innovation output. This study argues that the number of granted patents better reflects actual innovation performance than patent applications, which merely indicate firms' intention or emphasis on innovation rather than successful technological transformation. Therefore, the natural logarithm of one plus the total number of patents granted to a pharmaceutical firm in a given year is used to represent innovation activity.

#### (2) Dependent Variable

Corporate financial performance (**ROA**). Common indicators used to evaluate financial performance include Tobin's Q and return on assets (ROA). However, due to the high proportion of intangible assets and R&D expenditures in the pharmaceutical industry, Tobin's Q—which is based on book value—may inadequately capture the true value of intangible assets and is thus unsuitable for this context. Accordingly, this study adopts ROA, calculated as net profit divided by total assets, to measure financial performance. ROA provides a comprehensive assessment of profitability, asset utilization efficiency, and managerial effectiveness, and is well-suited to industries characterized by short product life cycles, such as pharmaceuticals.

#### (3) Control Variables

To improve estimation accuracy, several control variables were incorporated, including firm size (**Size**), leverage (**Lev**), growth (**Growth**), cash flow (**Cashflow**), board size (**Board**), and ownership concentration (**Top1**). All variable data were obtained from the CSMAR database and corporate annual reports.

- Firm size: measured as the natural logarithm of total assets. Large firms typically possess greater financial and human resources, enabling stronger patent output compared with small and medium-sized enterprises (SMEs). However, beyond an optimal scale, diminishing returns to scale may reduce financial performance. Therefore, firm size is included to control for scale effects.
- Leverage: measured as the ratio of total liabilities to total assets. It reflects a firm's financing structure and financial risk. Lower leverage generally indicates reduced financial exposure and safer innovation investment, which enhances investor confidence. Thus, leverage is controlled to prevent biased estimation due to financial distress.
- Firm growth: measured by the annual growth rate of total assets. Higher growth suggests a greater willingness and financial capacity to invest in R&D and patent development. Since firm

growth correlates with innovation output and financial performance, it is included as a control variable.

- Cash flow: measured as net operating cash flow divided by total assets. It reflects a firm’s ability to generate internal funds for innovation investment. Stronger cash flow facilitates innovation activities and enhances financial returns; therefore, it is controlled to avoid confounding effects.
- Board size: measured by the number of board members. Larger boards may provide more diverse expertise, improved strategic decision-making, and better governance support for innovation projects. Since board structure affects innovation efficiency and financial outcomes, board size is included as a control variable.
- Ownership concentration: measured by the shareholding ratio of the largest shareholder. High ownership concentration often reflects a conservative risk preference, discouraging high-risk, high-return innovation investment. Excessively concentrated ownership may also increase financing costs. Therefore, appropriate ownership distribution may encourage innovation and enhance financial performance, justifying its inclusion as a control variable.

### 3.3. Model Construction

A fixed-effects regression model was established to test H1 and heterogeneity hypotheses:

$$Roa_{i,t} = \beta_0 + \beta_1 Patent_{i,t} + \beta_2 Size_{i,t} + \dots + \beta_6 Top1_{i,t} + \mu_{i,t}$$

## 4. Empirical Results

### 4.1. Descriptive Statistics

Pharmaceutical firms show substantial variation in innovation levels and financial performance, indicating strong sample representativeness.

### 4.2. Correlation Analysis

**Table 1.** Correlation Analysis

|          | Roa       | Patent   | Size      | Growth   | Cashflow  | Lev       | Board | Top1 |
|----------|-----------|----------|-----------|----------|-----------|-----------|-------|------|
| Roa      | 1         |          |           |          |           |           |       |      |
| Patent   | 0.106***  | 1        |           |          |           |           |       |      |
| Size     | 0.049**   | 0.542*** | 1         |          |           |           |       |      |
| Growth   | 0.061***  | -0.038** | -0.065*** | 1        |           |           |       |      |
| Cashflow | 0.618***  | 0.134*** | 0.047**   | -0.045** | 1         |           |       |      |
| Lev      | -0.372*** | 0.128*** | 0.241***  | 0.026    | -0.257*** | 1         |       |      |
| Board    | -0.000    | 0.156*** | 0.216***  | -0.024   | -0.015    | 0.054***  | 1     |      |
| Top1     | 0.138***  | 0.001    | 0.038*    | 0.020    | 0.098***  | -0.118*** | 0.003 | 1    |

t statistics in parentheses, \* p < 0.1, \*\* p < 0.05, \*\*\* p < 0.01

The correlation results reveal the degree and nature of associations among the sample variables, as presented in Table 1. The correlation coefficient between corporate innovation and financial performance is 0.135 and is statistically significant at the 1% level, indicating a significantly positive relationship between the explanatory variable-corporate innovation-and the dependent variable-financial performance. Ownership concentration also exhibits a strong positive association with financial performance, suggesting that governance by major shareholders can substantially enhance corporate profitability. Conversely, leverage shows a negative correlation with financial performance, whereas cash flow demonstrates a strongly positive and highly significant correlation at the 1% level. This implies that sufficient operating cash flow directly strengthens firms’ return on assets, and cash flow may serve as the key

mediating factor through which leverage affects financial performance in pharmaceutical enterprises.

### 4.3. Benchmark Regression

To empirically test the research hypotheses proposed earlier, a fixed-effects regression model was employed, in which corporate financial performance served as the dependent variable and corporate innovation was specified as the core explanatory variable. The benchmark regression results examining the impact of innovation on the financial performance of pharmaceutical enterprises are presented in Table 2. Column (1) reports the baseline estimation without additional controls, while Column (2) presents the empirical results after incorporating firm-level micro-control variables.

The benchmark regression results indicate that corporate innovation exerts a significantly positive effect on financial performance. In Model (1), the coefficient of innovation is 0.256 and statistically significant at the 10% level, with an R-squared value of 0.529 and an adjusted R-squared of 0.469, suggesting a notable positive association between innovation and financial outcomes. After introducing firm size, growth rate, cash flow, and other control variables in Model (2), the coefficient of innovation increases to 0.297 and becomes significant at the 5% level. Meanwhile, the R-squared rises to 0.628 and the adjusted R-squared to 0.579, demonstrating that the inclusion of control variables substantially improves the model's explanatory power. These results further confirm that innovation plays a promoting role in enhancing the financial performance of pharmaceutical enterprises.

**Table 2.** Benchmark Regression

|             | (1)<br>Roa          | (2)<br>Roa            |
|-------------|---------------------|-----------------------|
| Patent      | 0.256*<br>(1.82)    | 0.297**<br>(2.31)     |
| Size        |                     | 0.011***<br>(3.92)    |
| Growth      |                     | 0.012***<br>(5.27)    |
| Cashflow    |                     | 0.436***<br>(23.49)   |
| Lev         |                     | -0.107***<br>(-12.12) |
| Board       |                     | 0.032**<br>(2.23)     |
| Top1        |                     | 0.139***<br>(7.16)    |
| Constant    | 0.049***<br>(14.92) | -0.294***<br>(-4.59)  |
| N           | 2903                | 2903                  |
| R2          | 0.529               | 0.628                 |
| Adjusted R2 | 0.469               | 0.579                 |
|             | (1)                 | (2)                   |

t statistics in parentheses, \* p < 0.1, \*\* p < 0.05, \*\*\* p < 0.01

### 4.4. Heterogeneity Analysis

#### 4.4.1. Heterogeneity Test based on Ownership Structure

According to the subgroup regression results reported in Columns (1) and (2), ownership structure significantly moderates the effect of patents on corporate financial performance. In

state-owned enterprises, the patent coefficient is  $-0.028$  and statistically insignificant, indicating that innovation investment in state-owned firms fails to translate effectively into improved profitability, and may even exhibit a slightly negative association. This outcome may stem from administratively driven innovation activities or soft budget constraints that lead to inefficient resource allocation. In contrast, the patent coefficient for non-state-owned enterprises is  $0.301$ , significantly positive at the 5% level, suggesting that market-oriented innovation enhances profitability through strengthened technological barriers or improved competitive advantages.

Regarding overall model explanatory power, the state-owned enterprise model reports an R-squared of  $0.656$  and an adjusted R-squared of  $0.600$ , while the corresponding values for non-state-owned enterprises are  $0.646$  and  $0.594$ , respectively. Although the explanatory strengths of the two models are relatively similar, the limited number of pharmaceutical state-owned enterprises in China ( $n = 619$ ) may constrain estimation accuracy and increase susceptibility to external disturbances, such as policy intervention or internal incentive mechanisms. These findings highlight the typical issue of “performance transformation failure” in state-owned enterprises, implying that future reforms should emphasize market-oriented restructuring to optimize the allocation of innovation resources. Conversely, non-state-owned enterprises may further leverage patent development to enhance innovation capability and consolidate innovation-driven financial gains.

**Table 3.** Heterogeneity Test Based on Ownership Structure

|             | (1)                       | (2)                       |
|-------------|---------------------------|---------------------------|
|             | Roa<br>(State)            | Roa<br>(Non-State)        |
| Patent      | $-0.028$<br>(-0.12)       | $0.301^{**}$<br>(2.02)    |
| Size        | $0.007$<br>(1.16)         | $0.011^{***}$<br>(3.19)   |
| Growth      | $0.010^{**}$<br>(2.04)    | $0.013^{***}$<br>(4.76)   |
| Cashflow    | $0.275^{***}$<br>(8.01)   | $0.473^{***}$<br>(21.93)  |
| Lev         | $-0.120^{***}$<br>(-6.70) | $-0.102^{***}$<br>(-9.84) |
| Board       | $-0.018$<br>(-0.66)       | $0.039^{**}$<br>(2.30)    |
| Top1        | $0.097^{**}$<br>(2.27)    | $0.147^{***}$<br>(6.28)   |
| Constant    | $-0.121$<br>(-0.81)       | $-0.295^{***}$<br>(-3.89) |
| N           | 619                       | 2277                      |
| R2          | 0.656                     | 0.646                     |
| Adjusted R2 | 0.600                     | 0.594                     |

t statistics in parentheses, \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

#### 4.4.2. Heterogeneity Analysis based on Firm Size

From the perspective of firm size heterogeneity, the correlation coefficient between corporate innovation and financial performance is  $0.432$  for large pharmaceutical enterprises and is statistically significant at the 5% level. This suggests that innovation exerts a significant positive impact on financial performance in large firms, likely due to their advantages in resource integration, commercialization capacity, and innovation scaling. In contrast, for small and medium-sized enterprises (SMEs), the economic benefits of innovation have not yet

materialized, possibly because limited R&D investment restricts innovation output and commercialization efficiency. However, the effect of firm growth on financial performance is significantly stronger in SMEs-0.018 compared with 0.007 in large firms-indicating that SMEs can leverage business expansion more efficiently to amplify financial returns. Overall, increases in innovation levels contribute more substantially to improving financial performance in large pharmaceutical enterprises than in SMEs, demonstrating that the positive financial impact of innovation is more pronounced among larger firms.

**Table 4.** Heterogeneity Analysis Based on Firm Size

|             | (1)            | (2)            |
|-------------|----------------|----------------|
|             | Roa<br>(Large) | Roa<br>(Small) |
| Patent      | 0.432**        | 0.051          |
|             | (2.21)         | (0.27)         |
| Size        | 0.017***       | 0.015***       |
|             | (3.08)         | (2.90)         |
| Growth      | 0.007**        | 0.018***       |
|             | (2.13)         | (5.07)         |
| Cashflow    | 0.422***       | 0.394***       |
|             | (15.71)        | (14.28)        |
| Lev         | -0.119***      | -0.113***      |
|             | (-7.67)        | (-8.42)        |
| Board       | 0.059***       | -0.026         |
|             | (2.69)         | (-1.09)        |
| Top1        | 0.163***       | 0.152***       |
|             | (4.86)         | (4.70)         |
| Constant    | -0.511***      | -0.273**       |
|             | (-4.01)        | (-2.38)        |
| N           | 1445           | 1436           |
| R2          | 0.661          | 0.670          |
| Adjusted R2 | 0.604          | 0.595          |

t statistics in parentheses, \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

#### 4.5. Robustness Tests

The robustness of the empirical findings was verified by replacing the dependent variable with return on equity, adjusting the patent measurement indicator (using annual patent applications), and modifying the sample range. The results consistently confirm the positive effect of patents on return on assets. Specifically, when return on equity was used as the dependent variable, the patent coefficient was 0.537 and statistically significant at the 5% level. After adjusting the patent indicator, the coefficient remained positive at 0.238 and significant at the 10% level. When the sample size was reduced, the coefficient remained 0.388, also significant at the 10% level, and the direction of influence was consistent with the benchmark model. Among the control variables, cash flow exhibited strong and robust significance, with coefficients ranging from 0.434 to 0.638, highlighting its universal explanatory power. The models' explanatory strength, reflected by R-squared values between 0.446 and 0.754, together with variable significance levels, demonstrates that the conclusions are highly robust to alternative measurement specifications and sample adjustments. However, the reduced sample size of 1,385 observations may introduce estimation bias due to the limited number of pharmaceutical enterprises in China; therefore, this result is not the focus of further discussion. Overall, the findings consistently support the conclusion that corporate innovation has a positive impact on financial performance.

**Table 5. Robustness Tests**

|                      | (1)                  | (2)                   | (3)                  |
|----------------------|----------------------|-----------------------|----------------------|
|                      | Roe                  | Roa                   | Roa                  |
| Patent               | 0.537**<br>(1.99)    |                       | 0.388*<br>(1.78)     |
| Size                 | 0.022***<br>(3.75)   | 0.012***<br>(4.35)    | 0.014*<br>(1.92)     |
| Growth               | 0.027***<br>(5.41)   | 0.012***<br>(5.25)    | 0.011***<br>(2.80)   |
| Cashflow             | 0.638***<br>(16.39)  | 0.434***<br>(23.42)   | 0.496***<br>(17.06)  |
| Lev                  | -0.108***<br>(-6.52) | -0.107***<br>(-12.06) | -0.143***<br>(-6.91) |
| Board                | 0.009<br>(0.30)      | 0.032**<br>(2.24)     | 0.023<br>(0.77)      |
| Top1                 | 0.255***<br>(6.24)   | 0.137***<br>(7.03)    | 0.030<br>(0.56)      |
| Current-year Patents |                      | 0.238*<br>(1.90)      |                      |
| Constant             | -0.520***<br>(-3.87) | -0.311***<br>(-4.91)  | -0.340**<br>(-2.05)  |
| N                    | 2903                 | 2903                  | 1385                 |
| R2                   | 0.446                | 0.627                 | 0.754                |
| Adjusted R2          | 0.374                | 0.579                 | 0.680                |

t statistics in parentheses, \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

## 5. Conclusion and Recommendations

### 5.1. Corporate Innovation Has a Significant Positive Effect on Financial Performance

Patent reserves, as a core indicator for measuring innovation output, not only serve as a quantifiable representation of technological barriers but also reflect the level of a firm's innovation capability and financial performance. In the digital era, enterprises should prioritize technological innovation, emphasize the commercialization and practical application of innovation outcomes, and enhance their core competitiveness. By signaling strong innovation capacity and promising sustainable development prospects to investors and the market, firms can improve financial performance, drive stock price appreciation, expand sales, secure greater market share amid fierce competition, increase profitability, and ultimately enhance overall financial outcomes.

### 5.2. Compared with Non-State-Owned Enterprises, the Positive Impact of Innovation on Financial Performance is More Significant in State-owned Pharmaceutical Firms

Patent output plays a more substantial role in improving financial performance among privately owned enterprises. This heterogeneity primarily stems from differences in ownership structure. Decision-makers in state-owned enterprises, driven by administrative performance evaluation and tenure considerations, tend to adopt conservative operational strategies and reduce high-risk technological innovation investment, resulting in fewer patents. In contrast, non-state-owned enterprises rely more heavily on the commercialization of innovation outcomes to build core competitiveness and obtain financing, which in turn strengthens their financial performance.

### 5.3. Compared with Large Enterprises, the Positive Financial Impact of Innovation is More Pronounced in Small and Medium-Sized Enterprises

SMEs can improve financial performance more effectively through innovation-driven growth. Due to common financing constraints, SMEs must depend on flexible operational strategies and efficient technological innovation to enhance profitability. They tend to place greater emphasis on innovation as a means of seizing development opportunities, improving financing capacity, and achieving survival advantages in competitive markets. Moreover, innovation enables SMEs to compensate for scale disadvantages, accelerate the industrialization of innovative outcomes, capture market opportunities, and ultimately convert innovation achievements into financial gains.

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